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CROSSLEY FARM/HEREFORD GROUNDWATER
HEREFORD TOWNSHIP, BERKS COUNTY, PENNSYLVANIA
CERCLIS NO. PAD981740061
FEBRUARY 1, 1993

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

[redacted]

AR300007

PRELIMINARY PUBLIC HEALTH ASSESSMENT

CROSSLEY FARM/HEREFORD GROUNDWATER

HEREFORD TOWNSHIP, BERKS COUNTY, PENNSYLVANIA

CERCLIS NO. PAD981740061

Prepared By:

The Health Assessment Team
Pennsylvania Department of Health
In Cooperative Agreement with the
Agency for Toxic Substance and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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TABLE OF CONTENTS

SUMMARY

The Crossley Farm (Hereford Groundwater) site is in the Huffs Church community of Hereford Township, Berks County, Pennsylvania. Illegal waste disposal activities reportedly occurred from the mid-1960s to mid-1970s. The waste of major concern is trichloroethylene (TCE). About 250 residents live hydrogeologically downgradient of the site (within two miles), and another 200 live within one-half mile upgradient of the site. In response to complaints made by the residents regarding odors in their private water supply wells, the Pennsylvania Department of Environmental Resources (PADER) initiated a sampling program in 1983. The sampling analyses revealed the presence of high levels of TCE (8,500 parts per billion (ppb)), and of tetrachloroethylene (PCE, 110 ppb). Again in 1986, in response to citizen complaints, EPA conducted additional rounds of sampling and found TCE at a maximum level of 22,857 ppb, and PCE at a maximum level of 224 ppb in residential wells. Human exposure to volatile organic compounds, particularly to TCE at high levels, occurred in the past. Furthermore, exposure to TCE is currently occurring and is likely to occur in the future. The estimated exposures are to substances in groundwater at concentrations that, upon long-term exposure, can cause adverse health effects to the receptor population. Therefore, the site poses an urgent public health hazard. Exposures since 1983 have been only partially mitigated by the installation of thirteen carbon filtration units by EPA and of a few privately installed units. An unknown number of residents are still being exposed through the use of untreated water during malfunction of existing filters, or because of the absence of such filters. Exposures before 1983, though fully expected, have not been thoroughly investigated.

The information and data developed for Crossley Farm, Berks County, Pennsylvania, have been evaluated by the Agency for Toxic Substances and Disease Registry's Health Activities Recommendations Panel (HARP) for appropriate follow-up with respect to health activities. Because of the past and current exposures and because of the possibility for future exposures to site contaminants, particularly TCE, at levels of public health concern, the panel determined that health professionals and community health education are needed. Also, biomedical testing, such as liver function tests, are indicated for those individuals who have been exposed to site contaminants through drinking contaminated private and public well water. Before the panel met, the site was accepted for inclusion on ATSDR's TCE subregistry. HARP concurs with that action. Other public health actions taken or planned by ATSDR for the site include an education program for public health professionals and the local medical community, and an evaluation of the feasibility of conducting biomedical testing for those individuals who have been exposed or who may yet be exposed to site contaminants through the use of private well water.

BACKGROUND

A. Site Description and History

The Crossley Farm site (Hereford Groundwater) is an area of contaminated soil, rock, and groundwater within fractured crystalline and carbonate rocks of the Hereford municipality in northeastern Berks County, Pennsylvania. The site is approximately 50 miles northwest of Philadelphia in scenic, rolling terrain (Appendix, Figure 1). The highland within the project study area is known as Blackhead Hill, a heavily-wooded, resistant knob underlain by quartzite and granite gneisses. The quartzite is attractive, tough, and valued as building stone. For those reasons, it was quarried from before 1946 (2). Exact dates of the beginning and ending of quarry operations are not known. From the quarry, the topography slopes steeply downward to a major north-south valley underlain by dolomite bedrock, and drained by a branch of Perkiomen Creek. Northeast of the quarry is a working farm on which corn and other crops are grown. A dirt road extends from the main highway in Huffs Church community all the way to the abandoned quarry. There are no restrictions on site to either foot or vehicular traffic; therefore, the site remains open to practically anyone who wishes to use it. There is even concern that illegal dumping may still be going on (see site visit section). One-quarter mile north of the quarry, another hilltop is being used for the storage/disposal of wood, broken concrete, miscellaneous household garbage, manure, at least one drum, and possibly industrial wastes (observations during site visits).

Illegal waste disposal reportedly took place near and within the quarry from the mid-1960s to the mid-1970s (2). Drums containing mostly liquid waste from Bally Case and Cooler (a local manufacturing firm) were emptied of their contents and apparently returned to be refilled. Magnetic surveys of the quarry area did not reveal the presence of metal anomalies, often associated with buried drums. The waste of concern was and is trichloroethene (TCE). As many as 300 drums may have been dumped within the quarry and in a small borrow pit about 400 feet to the east (Figure 2).

In 1983, local residents complained to the Pennsylvania Department of Environmental Resources (PADER) about odors in private water supply wells. A PADER sampling program begun in September 1983, revealed elevated levels of TCE and tetrachlorothene (PCE) in concentrations as high as 8,500 ppb TCE and 110 ppb PCE. Additional sampling by PADER and EPA Technical Assistance Team (TAT) contractor R.F. Weston in November, 1983 (1), confirmed the elevated TCE concentrations and roughly delineated a plume extending from the quarry about one-half mile down the hydrogeologic gradient. In the November sampling round, six of eight contaminated home wells showed TCE concentrations above 200 ppb. PADER promptly issued a health advisory on groundwater

use in the area. Shortly thereafter, a temporary water supply was provided by the Pennsylvania National Guard through the Pennsylvania Emergency Management Agency. That supply was ended by the Guard in mid-1985. Local residents began voicing concern about the Crossley Farm and the alleged dumping that took place there.

In response to those concerns, EPA requested that a preliminary assessment be conducted at the site. NUS Corporation performed a preliminary assessment of the site in early 1984. Based on conversations with PADER and Hereford Township representatives, and on an on-site inspection, it was concluded that there was insufficient information available for the Crossley Farm site, and a regional groundwater study was recommended. Concern about the site appears to have decreased until August 1986 (2).

Concern arose again in August 1986, in response to more citizen complaints, prompting additional rounds of sampling by Roy F. Weston (TAT) in September 1986. TCE contamination was again confirmed at levels ranging from 500 to 19,000 ppb in residential tap water. In October 1986, ATSDR performed a health consultation for EPA Region III (3). In November 1986, TCE was detected at a maximum level of 22,857 ppb. In due course, EPA requested that a regional hydrogeologic investigation be initiated in the spring of 1987. In January 1987, EPA began installing carbon filtration units on private wells downgradient of the site.

The EPA regional hydrogeologic investigation began in the spring of 1987 and was performed by Roy F. Weston and IT Corporation (1). The investigation included the construction of 21 monitoring wells, the performance of a soil gas survey, and sampling of monitoring wells and residential wells. Conclusions reached by the regional hydrogeologic investigation were that a large TCE contamination plume had been identified and that the source of this contamination was near the crest of Blackhead Hill.

Activity in the adjacent borrow pit area is evident in aerial photographs from as early as 1958, and appeared to increase in 1971. The borrow pit area is a clearing that appears to have been used to excavate topsoil. The exact type of activity and the years of operation are unknown for this area. Waste disposal activities have not been documented in the borrow pit area.

Simultaneous with the EPA investigation of Crossley Farm, an unrelated PADER investigation was underway at Texas Eastern compressor stations all across Pennsylvania. Residential wells south of the Bechtelsville station near Dale (Figure 1) were sampled for PCBs and other contaminants. Consequently, in the spring and summer of 1987, high TCE values (over 200 ppb) were detected in one well about 1,000 feet south of the Bechtelsville site. Since that time, it has been established that TCE was not and is not a predominant waste product of Texas Eastern operations

(4). Best evidence from groundwater sampling and geological investigations in the area suggests that the TCE contamination south and west of Dale are the result of illegal dumping at Crossley Farm nearly two miles to the north. If that is confirmed by future investigation and sampling, then the vertical and horizontal extent of the TCE plume is greater than indicated in the 1987 groundwater study (1). In December 1991, the last two carbon filtration units installed by EPA were placed in private residences near Dale. In September 1991, ATSDR performed a health consultation on the Crossley Farm site, in response to a request from the Pennsylvania Department of Health (PADOH) to review TCE contamination in private wells and to assess the impact of the contaminant plume on residential wells. In that consultation, ATSDR concurred with PADOH's recommendation that the plume needs to be defined and all private and public wells that could be potentially affected by the groundwater contamination should be determined and monitored.

B. Site Visits

On September 6, 1991, J.E. Godfrey of the Pennsylvania Department of Health (PADOH) visited the site to conduct a geological investigation of the area. On September 17, 1991, Greg Ulirsch and Charles Walters of ATSDR; J.E. Godfrey, Gary Schultz, and Tom Hartman of PADOH; EPA officials; and a representative of Roy Weston, Inc., visited the site, made a general tour of the affected area, and talked with local residents. Following a conference call with EPA, ATSDR, and PADOH the next day, plans were made to conduct an additional round of water well sampling with special emphasis on residents to the south either who might have been missed previously, or who might have experienced an increase in TCE concentrations after the drought of summer 1991 (5). That sampling was conducted in October and November 1991.

Before meeting with residents on the afternoon of September 17, 1991, J.E. Godfrey, Tom Hartman, Greg Ulirsch, and representatives of EPA and Roy Weston, Inc., visited the quarry and located monitoring wells in the field (Figure 3). Mr. Godfrey pointed out some of the faults that have facilitated contaminant migration to the west and south (1). The team members saw evidence of recreational activities (camp fire site, unopened beer cans) on the unfenced site, and how conveniently liquid waste could still be disposed over the quarry rubble and directly into bedrock. Piles of old tires and other rubbish flanked the roads leading to the quarry (Figure 2).

As the team was leaving the site to join other officials, a tanker truck was observed coming down the road leading to the quarry. The vehicle bore Montgomery County tags and was allegedly about to off-load sewage sludge from the Upper Montgomery Joint Authority, Pennsburg, Pennsylvania. The sludge was for agricultural spreading on the farm, and this activity is legal

under existing regulations. However, the inspection team was impressed at the ease with which nearly any vehicle carrying any cargo can still gain access to the site.

On November 6, 1991, J.E. Godfrey visited the site with Dr. Ginger Gist of ATSDR, in preparation for community meetings and the possible inclusion of some residents in the TCE subregistry.

C. Demographics, Land, and Resource Use

The Crossley Farm is located in the Huffs Church community of Hereford Township, Berks County, Pennsylvania. It is 50 miles northwest of Philadelphia and 21 miles northeast of Reading. Approximately 250 residents live hydrogeologically downgradient of the site (within two miles), and another 200 live within one-half mile upgradient of the site. Population estimates are based upon a reconnaissance and home counting in the area of concern.

The land use is largely residential and agricultural. A few small stores and businesses are located in Huffs Church. A local historical landmark (old foundry) is situated just north of Dale. The upland areas are underlain by resistant metamorphic rocks that rise some 350 feet above the dolomite valley (Figures 1 and 3). Corn, hay, pastureland, and farm vegetables appear to be the major crops produced. The Crossley Farm itself was once a working dairy; however, the exact dates of operation are unknown.

A local resident stated during an interview that rock from the quarry was primarily used as building stone.

Area residents get nearly all of their water from drilled wells and springs. An undetermined number of people supplement their well water with bottled water. Acceptable volumes of groundwater are usually obtained from wells 300 feet deep or shallower (1). The local aquifer consists of fractured bedrock with probable solution openings in the areas underlain by dolomite. Most springs that are known to be used are outside the groundwater flow regime contaminated by the site. However, some springs downgradient of Crossley Farm are contaminated with volatile organic compounds. Owners and/or users of contaminated springs have been informed of this condition and advised not to drink from them. It is possible, nevertheless, that contaminated springs unknown to investigators exist downgradient of the site and may be used for potable or recreational purposes (bathing, wading, fishing).

At least one public water supply (serving a mobile home park) is located within one-half mile of the site. That system serves about 38 connections from two water supply wells, one of which appears to be contaminated by the household dump on the site (Figure 2). Since July 1989, the park has been treating its water

with activated carbon. The complete history and contamination status of the water supply before 1989 are not known.

D. Health Outcome Data

Using state health data bases, special studies or other relevant health outcome data bases, we may be able to determine whether certain health effects are higher than expected in areas surrounding hazardous waste sites. This section introduces those data bases and discusses their limitations. An evaluation of the usefulness of health data as they relate to the Crossley Farm site is presented in the Public Health Implications section of this document.

PADOH has maintained death records since 1903. The Pennsylvania Cancer Registry has collected cancer data for all areas of Pennsylvania only since 1984. Field representatives interact with local hospitals to audit the accuracy of all reporting. However, the mobility of the patients, the variance in compliance rates among hospitals, and the newness of the program create difficulty in analyses of geographic areas smaller than the county level. The most recent report, published in July 1991, is entitled Cancer Incidence and Mortality in Pennsylvania, 1987. The report presents data applicable only at the county level (smallest geographic area). PADOH is unaware of the existence of any special studies or other relevant health outcome data bases associated with this site.

COMMUNITY HEALTH CONCERNS

Before EPA and PADER involvement, residents complained of odors and skin irritations apparently associated with high TCE concentrations. The primary health concerns of local residents were gathered during field visits and interviews, and are shown below:

1. What are the adverse health consequences of past and present exposure to TCE and PCE in well water?

2. How long have I (we) been exposed to TCE and PCE through groundwater?

3. Will the carbon filtration unit on my well adequately protect me from exposure to TCE and PCE?

4. What adverse health effects will result from a malfunction or failure of the carbon filtration system?

The above health concerns will be addressed in the Community Health Concerns Evaluation section.

The PADOH conducted public comment for the Crossley Farm Preliminary Public Health Assessment. A Public Notice appeared in The Reading Eagle Times on July 28, 1992 announcing the public comment period for this document. The PADOH accepted public comments between July 28, and August 28, 1992. In addition to the PADOH Public Notice, ATSDR's Division of Health Studies sent copies of the public comment release public health assessment directly to all site-related members of the TCE subregistry. During the public comment period, no comments were received by the general public or from the TCE subregistry members.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

The tables in this section list the contaminants of concern. We evaluate these contaminants in the following sections of the public health assessment and determine whether exposure to them has public health significance. PADOH selects and discusses these contaminants based upon several factors, including (a) concentration of chemicals on site and off site; (b) comparison of on-site and off-site concentrations with health assessment comparison values for carcinogenic and non-carcinogenic end points, and (c) community health concerns.

In the data tables under On-Site Contamination and Off-Site Contamination, the fact that a contaminant is listed does not mean that it will cause adverse health effects from exposure. Instead, the list indicates which contaminants will be evaluated further in the public health assessment. When selected as a contaminant of concern in one medium, the contaminant will be reported in all media sampled.

Comparison values for health assessments are contaminant concentrations in specific media that are used to select contaminants for further evaluation. These values include Environmental Media Evaluation Guides (EMEGs), Cancer Risk Evaluation Guides (CREGs), and other relevant guidelines. CREGs are estimated contaminant concentrations based on a one excess cancer in a million persons exposed over a lifetime (70 years). Maximum Contaminant Levels (MCLs) represent contaminant concentrations that EPA deems protective of public health over a lifetime at an exposure rate of 2 liters of water per day. Proposed Maximum Contaminant Levels (PMCLs) are MCLs that are being proposed by EPA.

We conducted a search of the EPA Toxic Chemical Release Inventory (TRI) for the site and local area, but TRI did not show any facilities as having made chemical releases. It is known, however, that the Texas Eastern facility northwest of Dale discharged PCBs into the soil and groundwater during its operation from the 1950s until the early 1980s (4).

At the time of this preliminary site investigation, historical information and citizen complaints indicated that the primary method of introducing contaminants into the environment was by direct dumping of liquid solvents on and into exposed bedrock. Therefore, the focus of the investigation was directed toward contaminant migration in the groundwater flow system. Air contamination and surface water and soil contamination were not expected to be significant, so those media were not sampled. Our assessment, likewise, concentrates on groundwater, but we will discuss the need for additional media sampling and analyses in the appropriate sections of the report.

A. On-Site Contamination

Groundwater - Monitoring Wells

From December 1987 to May 1988, the EPA contractors installed a total of 21 monitoring wells. Eight wells were installed on site. Figure 4 shows the well locations, and indicates which wells were nested to monitor groundwater at different depths, from overburden (20 feet) to deep bedrock (300 feet). The table in Appendix B-1 gives construction details of all monitoring wells, and Table 1 reports the contaminants of concern and the maximum concentrations for on-site wells. TCE detected in the wells greatly exceeds our comparison values. From the monitoring wells, we may conclude that (a) shallow and deep portions of the aquifer are thoroughly connected by fractures (all zones are contaminated); (b) contamination is greatest along faults (MW1-R); (c) contamination is greatest in bedrock wells (MW1-R), and (d) all rock types are contaminated and, hence, connected by a pervasive fracture network.

A serious data gap is evidenced by the fact that on-site groundwater has been analyzed for volatile organic compounds (VOCs), including vinyl chloride, but not for pesticides and metals. Farms in particular, commonly use, store, and dispose of pesticides in relatively large volumes (55 gallon drums), further emphasizing the need for expanded sampling on this site. During site visits, a number of drums were observed along the entrance road and in the household dump (Figure 2).

Table 1. Contaminant Concentration in On-Site Groundwater Monitoring Wells (1)

CONTAMINANT	MAXIMUM CONCENTRATION PPB	COMPARISON VALUE	
		PPB	SOURCE
Trichloroethene (TCE)	19,300	5/0	MCL/MCLG
Tetrachloroethane (PCE)	ND	5/0	MCL/MCLG

PPB - Parts Per Billion
ND - Not Detected
MCL - Maximum Contaminant Level (EPA)
MCLG - Maximum Contaminant Level Goal (EPA)

Soil Gas Survey

During the week of March 7, 1988, a soil gas survey was performed on site. Samples were extracted from a network of stainless steel probes 5 feet long and half an inch in diameter. A follow-up survey was performed in June 1988. Samples were analyzed for total volatile organic compound concentrations with special additional emphasis on TCE (maximum value 3,400 ppb) and PCE (maximum value 1,695 ppb). Figure 5 shows the soil sampling transects and Figure 6 graphically portrays the analytical results.

With the exception of point Q84 (an anomaly probably caused by surface spillage associated with farm equipment), all indications of TCE occur near or downgradient of the rock quarry and the borrow pit. This information, when combined with monitoring well data, strongly implicates these two areas as sources for the regional groundwater contamination (1). A third source is undoubtedly the open dump one-quarter mile north of the quarry on the same farm property.

No other media were sampled in this preliminary field investigation because the principal medium of exposure is and was expected to be groundwater. A data gap exists, however, for on-site data because the household dump has been virtually uninvestigated for any medium.

B. Off-Site Contamination

Groundwater - Monitoring Wells

The EPA contractor installed 13 off-site monitoring wells (Figure 4 and Appendix B-1). Except for well No. 8, multiple vertical zones were monitored at each location. Wells No. 4 and No. 5 were situated along faults expected to be major contaminant pathways. Table 2 gives the maximum values for TCE and PCE contamination during the May, 1988 sampling event. The same

contaminant characteristics discovered on site continued off site; highest contamination along faults, highest contamination in deep bedrock, shallow and deep zones affected, all rock types connected by fractures both vertically and horizontally.

As with the on-site work, VOCs were the only parameters analyzed. Thus, data gaps exist for analytes (metals, pesticides) and for other media such as surface water and aquatic biota. It is hoped that these deficiencies will be addressed during the Remedial Investigation.

Table 2. Contaminant Concentration in Off-Site Groundwater Monitoring Wells (1)

CONTAMINANT	MAXIMUM CONCENTRATION PPB	COMPARISON VALUE	
		PPB	SOURCE
Trichloroethene (TCE)	4,019	5/0	MCL/MCLG
Tetrachlorqethane (PCE)	79	5/0	MCL/MCLG

PPB - Parts Per Billion
MCL - Maximum Contaminant Level (EPA)
MCLG - Maximum Contaminant Level Goal (EPA)

Groundwater - Residential Wells

In May 1988, the EPA contractor sampled 38 residential wells for VOCs in the area around Crossley Farm. Fifteen wells showed TCE levels above the MCL and one well showed elevated PCE. Table 3 reports the maximum values of TCE and PCE for residential wells for the entire period of sampling beginning in 1983 and ending in November 1991. An interesting point is that the maximum value (TCE) for residential wells exceeds that for monitoring wells on site. That is because the residential well in question was fortuitously located on a major geologic fault downgradient of the quarry (Figures 2,3).

Table 3. Contaminant Concentration in Off-Site Residential Wells, PPB (1)

CONTAMINANT	MAXIMUM CONCENTRATION		COMPARISON VALUE	
	1983 TO MAY 1991	SEPT TO NOV 1991	PPB	SOURCE
Trichloroethene (TCE)	22,857*	4,800	5/0	MCL/MCLG
Tetrachloroethane (PCE)	224	NS	5/0	MCL/MCLG

PPB - Parts Per Billion
MCL - Maximum Contaminant Level (EPA)
MCLG - Maximum Contaminant Level Goal (EPA)
*Occurred in November 1986
NS - Not Sampled

No data on pesticides, metals, or semi-volatile compounds exist for off-site residential wells. Also unknown are those residents, if any, who consumed water from contaminated springs. Therefore, this lack of information represents yet another data gap.

C. Quality Assurance and Quality Control

In preparing this public health assessment, PADOH relied on the information provided in the referenced documents and gathered during site visits and interviews. The Department assures that adequate quality control measures were followed regarding chain-of-custody, laboratory procedures, and data processing. Our analyses and conclusions in this assessment are valid only if the information listed in the bibliography is complete and reliable.

D. Physical and Other Hazards

The open quarry presents a physical hazard to site visitors. Injury from falls or from unstable boulders subject to sliding or rolling is possible as long as the site remains unrestricted.

PATHWAY ANALYSES

To determine whether nearby residents are exposed to contaminants migrating from the site, PADOH evaluated the environmental and human components that lead to human exposure. This pathway analysis consists of five elements, a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population.

PADOH categorizes an exposure pathway as a completed or potential exposure pathway if the exposure pathway cannot be eliminated. Pathways are considered to be complete when all pathway components are present or likely present. Potential pathways exist where one or more elements are possible but are not identified in the data available at the time the public health assessment is conducted. The pathway is eliminated if the missing component is never likely to occur.

A. Completed Exposure Pathways

Private Well Pathways

Past, current, and future exposure pathways are possible from contaminated groundwater in private wells. A completed exposure pathway exists over time because three routes of exposures (inhalation, ingestion, skin contact) and three time frames exist. Contaminants move from the source area(s) as precipitation carries them to groundwater, then through a complex fracture network to wells where groundwater users downgradient of the site are exposed.

Since 1983, at least 21 residential wells have shown TCE contamination above 5.0 ppb during one or more sampling events. TCE levels in eight wells have exceeded 1,000 ppb. Twelve residential wells have shown PCE levels above 5.0 ppb. These are regarded as the minimum number of exposure points because (a) the plume may be larger than previously thought, and (b) some residents refuse to have their wells sampled. Thirteen homes have been fitted with carbon filtration units by EPA, and an unknown number of residents have installed filters at their own expense. Since the day-to-day effectiveness of the various treatment systems is not known, a completed exposure pathway may exist even for those using treated water.

Public Well Pathways

The Woodland Mobile Home Park has two water supply wells, one of which is contaminated with TCE at concentrations as high as 111 ppb (PADER data). Therefore, public well users are exposed through inhalation, ingestion, and dermal contact just as private well users are. As discussed in the Resource Use section of this report, the source of this contamination is thought to be the household dump on Crossley Farm. With some 38 units at peak capacity, the park serves approximately 130 persons at any given time. It is believed that for most of the 1980s, the contaminated well served only a portion of the park. A carbon filtration unit was installed in the summer of 1989. Reliable estimates of exposure before 1989 are not possible from existing data.

The turnover of occupants for this establishment is not known; however, PADER regularly inspects the water supply to assure that the treatment system now produces finished water meeting EPA safe

drinking water standards. The quality of this water supply before 1983 has not been determined.

B. Potential Exposure Pathways

Rural properties near Crossley Farm continue to be developed for residential use. When new homes and private wells are constructed downgradient of the site, there exists a potential for more exposure from contaminated groundwater. Deep wells (greater than 200 feet) are particularly prone to contamination because vertical components of groundwater flow have taken the chemicals of concern far down into the aquifer. It is doubtful that residents new to the area fully appreciate the nature and extent of this problem. As might be expected, several homes are for sale, and each uninformed buyer represents a new potential receptor(s).

Because of the way TCE and PCE were introduced into the environment at the quarry, media other than groundwater were not expected to be significant contaminant transporters, and no data exist for them. They have, therefore, been omitted from discussion in this assessment. Suggestions for additional media and pathways investigations appear in the Recommendations section of this document.

The open dump appears to be a source for continued groundwater contamination and for exposure through direct contact with unspecified wastes. Individuals who dump or who use the site for recreation are potential receptors. We cannot make a conclusive evaluation of this area, however, because of a complete lack of data regarding it. That, too, will be addressed in the Recommendations section.

PUBLIC HEALTH IMPLICATIONS

In this section, we will discuss the health effects in persons exposed to specific contaminations, evaluate state and local health data bases and address specific community health concerns.

A. Toxicological Evaluation

Introduction

To evaluate health effects, either a Minimum Risk Level (MRL) for contaminants developed by ATSDR, or a Reference Dose (RfD) developed by EPA has been used. The MRL is an estimate of daily exposure to a contaminant below which non-cancer adverse health effects are unlikely to occur. The RfD is an estimate of a daily exposure (mg/kg/day) to the general public (including sensitive groups), which is likely to be without an appreciable risk of deleterious effects during a life-time exposure (chronic RfD) or exposure during a limited time interval (subchronic RfD).

Trichloroethylene (TCE)

TCE exposure has occurred or is occurring to off-site residents via well water through ingestion, inhalation and skin contact. Currently, there are no chronic MRL or RfD values available for this chemical. Using the highest TCE concentration detected in a private well (22,857 ug/L), the ingestion exposure for adults and children does exceed ATSDR's intermediate oral MRL. Exposure of area residents to TCE over many years by inhalation, ingestion, and skin absorption may result in carcinogenic and non-carcinogenic effects. The nervous system is probably the most sensitive system that will show adverse health effects from chronic exposure to TCE. It is not possible to determine how likely neurologic health effects are to occur in residents who have been exposed to TCE. In addition, animal studies have shown that ingesting or breathing TCE can produce liver and kidney damage, and can have effects on the blood. Results of a few studies in pregnant animals exposed to TCE in air or in food showed effects on unborn animals or on newborns. At present, information is not sufficient to determine whether these effects can occur in humans (6).

Occupational studies of workers exposed to TCE have not detected TCE-induced cancer, but several animal studies have shown that TCE can produce lung and liver cancer (6). Animal studies also have shown that TCE can cause leukemia, a cancer of the tissues that form white blood cells. In reviewing the animal studies, the Department of Health and Human Services' (DHHS) National Toxicology Program could not find clear evidence that TCE causes cancer in animals. The International Agency for Research on Cancer (IRAC), an agency that classifies chemicals according to their carcinogenicity, has decided that TCE is not classifiable as carcinogenic in human beings (6). However, EPA classified TCE as a probable human carcinogen based upon some animal studies. Based on these animal studies we estimate the persons exposed to TCE in the private wells at high concentrations may have a moderate risk of developing cancer over a lifetime. Some uncertainty, however, exists in this cancer estimate.

Tetrachloroethene (PCE)

PCE exposure has occurred or is occurring to off-site residents via well water through ingestion, inhalation, and skin contact. Ingestion exposure to PCE exceeds the chronic RfD for children but not for adults. Children, therefore, have a slightly greater risk of experiencing noncancerous adverse health effects from their exposure to PCE through ingestion and inhalation. PCE may damage the lungs, liver, kidneys, and central nervous system. Information on noncancerous adverse health effects as a result of dermal contact is limited. Eye irritation has been seen in workers who are exposed to much higher levels of PCE than what has been found in private wells (10). Therefore, no noncancerous adverse health effects are expected to result from dermal contact with PCE in private well water.

Studies of occupational workers have not linked PCE to cancer in humans. Animal studies, however, have shown that PCE will cause cancer (7). The level of exposure in these animal studies was several thousand times greater than the level in the exposed population at this site. Based on these animal studies, we estimate that persons exposed to PCE in the private wells, at the highest concentration detected, may have no apparent increased risk of developing cancer over a lifetime. However, exposure to this chemical should be either eliminated or reduced to the lowest level possible.

B. Health Outcome Data Evaluation

The Crossley Farm site is in Hereford Township, Berks County. Twenty-one years of all cause mortality and cancer mortality (total cancer and eight cancer sites) were collected for Hereford Township and Bally Borough. Bally Borough is south of the site but in the direction of the contamination plume (8). The 1979-1989 data were analyzed using Pennsylvania's 1979-1981 mortality as a standard and the 1980 Census population for age and sex.

Total deaths (all causes) were considerably below the expected number of deaths for the 1979-1989 period in Hereford Township. There were 178 observed deaths while 229.8 deaths would have been expected. An "expected" death or death rate is a statistical term used for measuring mortality (deaths) or morbidity (cases) among a specified population. In this case, the age-sex specific death rate (45-49 year old males, for example) for a selected cause of death for Pennsylvania is applied to the same age-sex population in Hereford Township to obtain an "expected number of deaths." This tells the investigator how many deaths one would expect to see in Hereford Township if the mortality was the same as in the standard population of Pennsylvania. There were 43 observed cancer deaths in Hereford Township where 49.8 deaths would have been expected. In Bally Borough, there were 100 observed deaths in the period, and

113.2 deaths expected; 22 were cancer deaths, with 24.6 cancer deaths expected. None of these differences were unusual, nor were any of the differences in the eight cancer sites for Hereford Township or Bally Borough. (From a mathematician's perspective, these differences were not statistically significant) (9). The cancer sites were: (a) buccal cavity and pharynx; (b) digestive system; (c) respiratory system; (d) bone, connective tissue, skin and breast; (e) genitourinary system; (f) other and unspecified sites; (g) leukemia, and (h) other lymphatic and hematopoietic tissues.

C. Community Health Concerns Evaluation

We have addressed the community concerns about health as follows.

1. What are the adverse health consequences of past and present exposure to TCE and PCE in well water?

Exposure to TCE and PCE detected in some private wells and public wells may cause adverse health effects for residents. As stated in the toxicological evaluation, the nervous system is probably the most sensitive system that may show adverse health effects from chronic exposure to TCE. However, it is not possible to determine how likely the neurologic effects are to occur in residents. In addition, some animal studies have shown that PCE and TCE can produce cancer. However, occupational studies of workers exposed to TCE and PCE have not detected TCE- and PCE-induced cancers. As stated earlier in the Toxicological Evaluation section, there are some uncertainties regarding the carcinogenicity of TCE in humans. Based on these animal studies, we estimate that persons exposed to high levels of TCE in their private wells may have a moderate risk of developing cancer. Some uncertainty, however, exists in this cancer risk estimate. This estimate is based on extrapolations from animal studies that overestimate human cancer cases.

Exposure to high concentrations of TCE detected in some residential wells may cause irritation of the skin, eyes, nose, and throat, as well as headache and dizziness, especially in chemically sensitive individuals.

2. How long have I (we) been exposed to TCE and PCE through groundwater?

Exposure time interval can only be estimated from the data available. The best historical information (see Background section) and estimates of groundwater/contaminant travel times indicate a range of 15 to 25 years of exposure for most long-term residents, depending upon when (or if) carbon filtration was installed. Transients and home owners with the first carbon filtration units will have suffered less exposure

(15 years or less) while long-term residents with no water treatment (since the mid-1960s) may have been exposed for 25 years or more.

3. **Will the carbon filtration unit on my well adequately protect me from exposure to TCE and PCE?**

Carbon filtration units installed and maintained by EPA offer good protection against exposure as long as no malfunctions occur (leaks, particulate clogging). We cannot speak for the effectiveness of treatment systems installed by individual home owners, some of whom refuse to have their water tested by EPA or PADER.

4. **What adverse health effects will result from a malfunction or failure of the carbon filtration system?**

If treatment systems fail, then exposure to TCE and PCE will occur, and the effects described in #1, above, may be manifested in some users of contaminated groundwater.

CONCLUSIONS

Based on the information reviewed, PADOH has concluded that this site presents an urgent public health hazard. As noted in the Pathway Analyses section, human exposure to volatile organic compounds, particularly to TCE at high levels, occurred in the past. Furthermore, exposure to TCE is currently occurring and is likely to occur in the future. The estimated exposures are to substances at concentrations in the environment which, upon long-term exposure, may cause adverse health effects to the receptor population. Past, current, and future completed exposure pathways to TCE and PCE in groundwater exist for residents near the site.

RECOMMENDATIONS

Cease/Reduce Exposure Recommendations

1. Provide residents whose water supplies exceed 5 ppb TCE with appropriate treatment systems, or an uncontaminated alternative water supply.

2. Expeditiously remove existing waste pile north of the quarry. This action will reduce or eliminate a continuing source of groundwater contamination for the northern part of the plume (Figure 2).

3. Restrict public access to the parts of Crossley Farm where dumping has occurred and continues to occur. This measure will prevent continued illegal dumping, reduce exposure through direct contact with potentially contaminated soil and/or refuse, and eliminate a potential source of groundwater contamination.

Site Characterization Recommendations

1. Design the final monitoring well network to monitor deep flow zones as well as the horizontal plume dimensions. Drought conditions have forced local residents to replace dry shallow wells with deeper wells that are more likely to intercept highly contaminated groundwater. Therefore, a better understanding of the deep flow zones is imperative. The placement of the monitoring wells should be sufficiently dense to detect any southward migration of the highly contaminated plume core.

2. Immediately sample all residential wells (and springs) along Perkiomen Creek between Woodland Mobile Home Park and Barto. Continue to sample at least twice yearly until the Remedial Investigation is completed. Based upon a PADOH recommendation, EPA has recently sampled several wells between Dale and Barto. However, the results of this sampling are not yet available.

3. Expand the existing monitoring well network to characterize the open dump area. This will probably confirm the dump as the source of contamination for the mobile home park.

4. Perform a complete soil investigation in the dump area after the waste pile is removed.

Health Activities Recommendation Panel (HARP) Recommendations

The information and data developed for Crossley Farm, Berks County, Pennsylvania, have been evaluated by ATSDR's Health Activities Recommendations Panel for appropriate follow-up with respect to health activities. Because of the past, current, and possible future exposure to site contaminants, particularly TCE, at levels of public health concern, the Panel determines that health professionals and community health education are needed. Also, biomedical testing, such as liver function tests, are indicated for those individuals who have been exposed to site contaminants through drinking contaminated private and public well water. Before the Panel meeting, the site was accepted for inclusion on ATSDR's TCE subregistry. HARP concurs with this action.

PUBLIC HEALTH ACTIONS

The Public Health Action Plan (PHAP) for the Crossley Farm/Hereford Groundwater site contains a description of actions to be taken by ATSDR at and in the vicinity of the site. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse health effects resulting from exposure to hazardous substances in the environment. Included, is a commitment on the part of ATSDR to follow up on this plan to ensure that it is implemented. The public health actions taken or planned by ATSDR are as follows:

Public Health Actions Taken

1. ATSDR, through its Division of Health Studies, has accepted this site for inclusion on the TCE subregistry.

2. ATSDR, through its Division of Health Education, and in conjunction with the local medical community, conducted an environmental health education program. The program advised the public health professional and the local medical community of the nature and possible consequences of exposure to contaminants at the Crossley Farm site. The value of obtaining a complete and accurate exposure history was stressed as part of this program. In addition, information that was provided on the contaminants of concern included, but not limited to, the physical nature of the contaminant, potential exposure pathways (e.g., soil, water, air) and exposure routes (e.g., inhalation, ingestion), potential health effects, symptoms of exposure, and testing and treatment, if known.

Public Health Actions Planned

1. ATSDR will evaluate the feasibility of conducting biomedical testing (e.g., liver functioning tests) for those individuals who have been or may still be exposed to site contaminants through use of private well water.

2. ATSDR will coordinate with the appropriate environmental agencies to develop plans to implement the cease/reduce exposure and site characterization recommendations contained in this public health assessment.

3. ATSDR will provide an annual follow up to this PHAP, outlining the action completed and those in progress. This report will be placed in repositories that contain copies of this public health assessment, and will be provided to persons who request it.

ATSDR will reevaluate and expand this Public Health Action Plan when needed. New environmental, toxicological, or health outcome data, or the results of implementing the above proposed actions may determine the need for additional actions at this site.

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CERTIFICATION

This public health assessment was prepared by the Pennsylvania Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was begun.

Technical Project Officer, SPS, RPB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment, and concurs with its findings.

Director, DHAC, ATSDR

REFERENCES

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6. Agency for Toxic Substances and Disease Registry, 1992, Toxicological Profile for Trichloroethylene. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

7. Agency for Toxic Substances and Disease Registry, 1990, Toxicological Profile for Tetrachloroethylene. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

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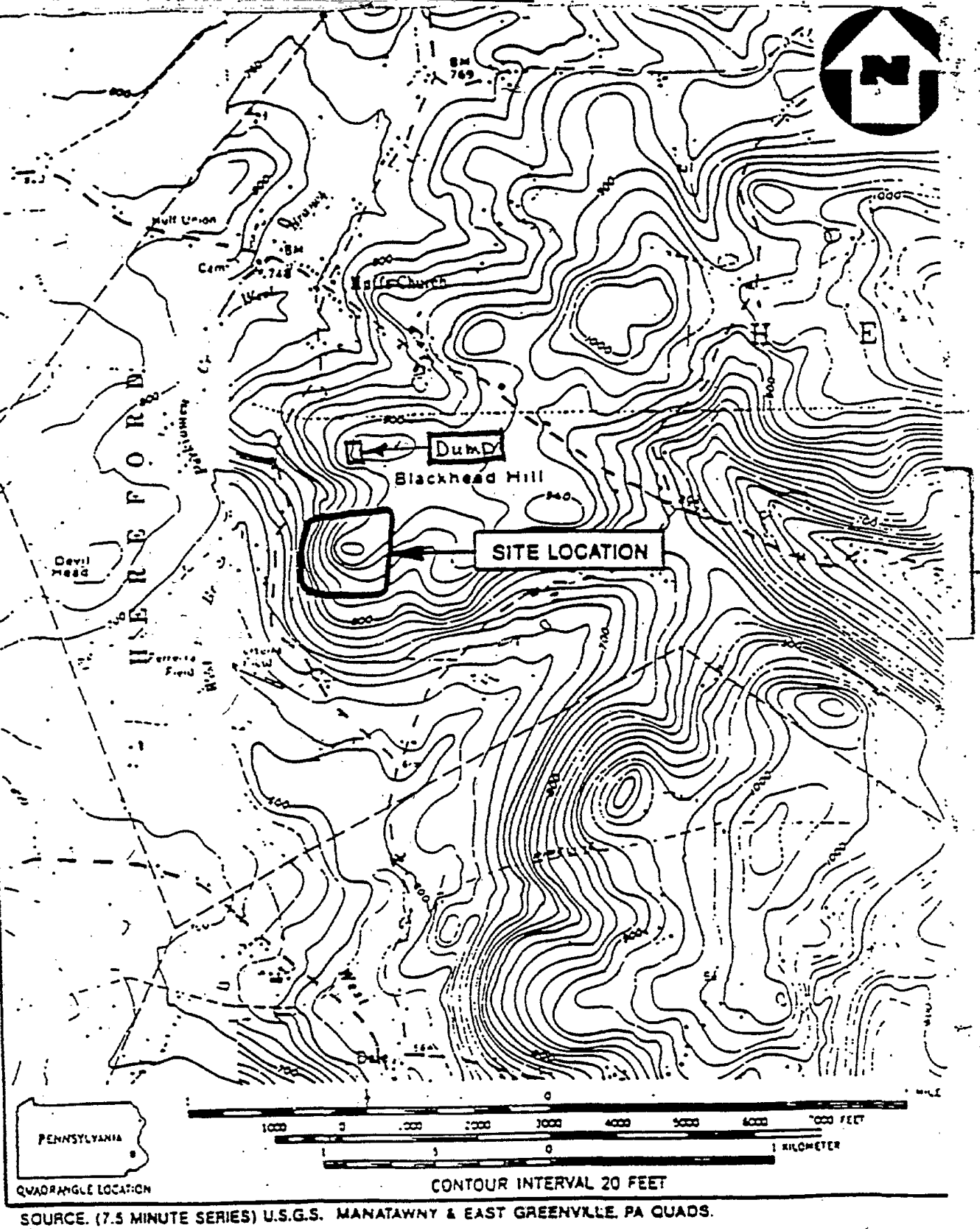
APPENDICES

APPENDIX A

FIGURES



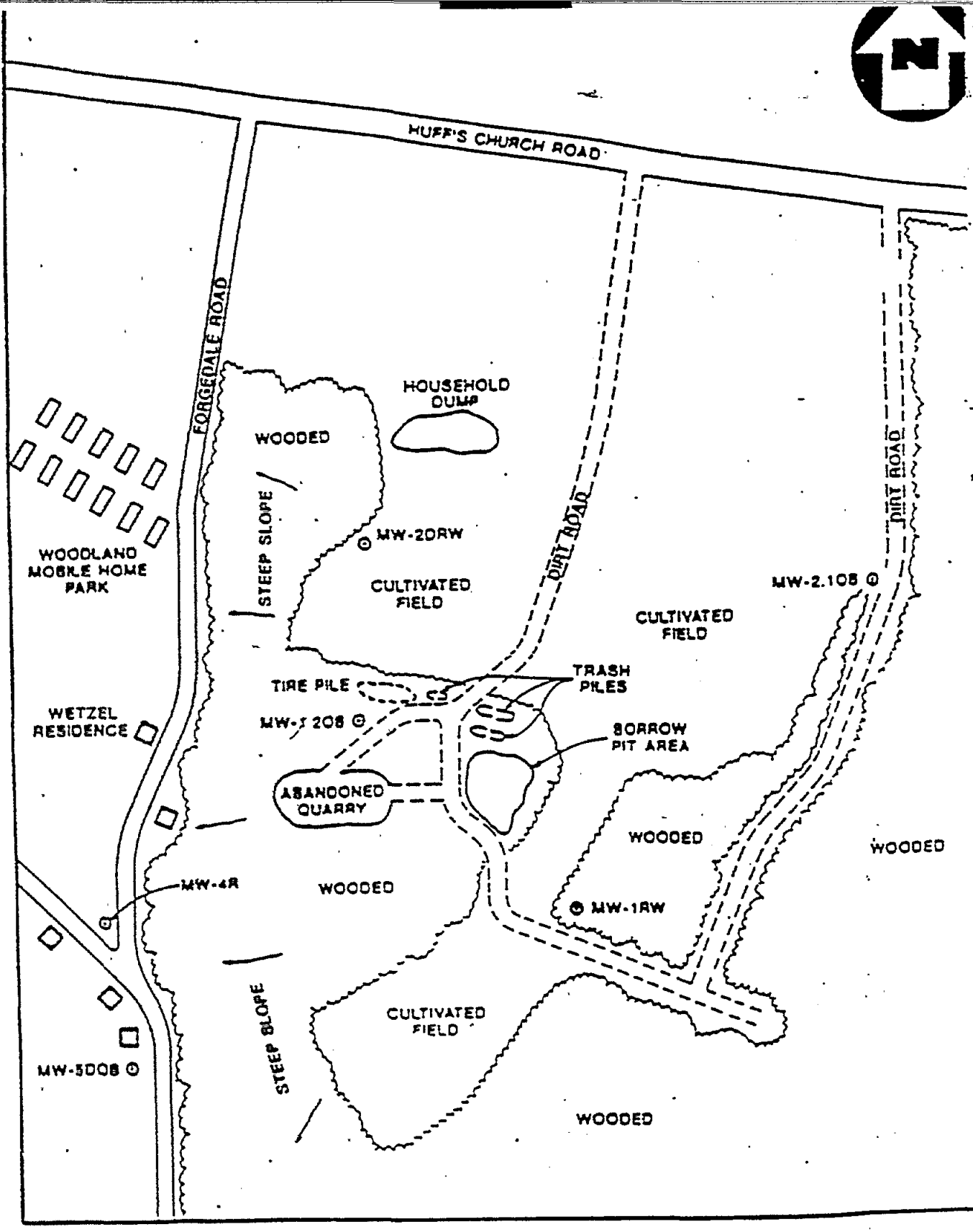
SOURCE. (7.5 MINUTE SERIES) U.S.G.S. MANATAWNY & EAST GREENVILLE, PA QUADS.

SITE LOCATION MAP

FIGURE 1

CROSSLEY FARM SITE, BUCKS CO., PA

SCALE 1: 24000



SITE SKETCH

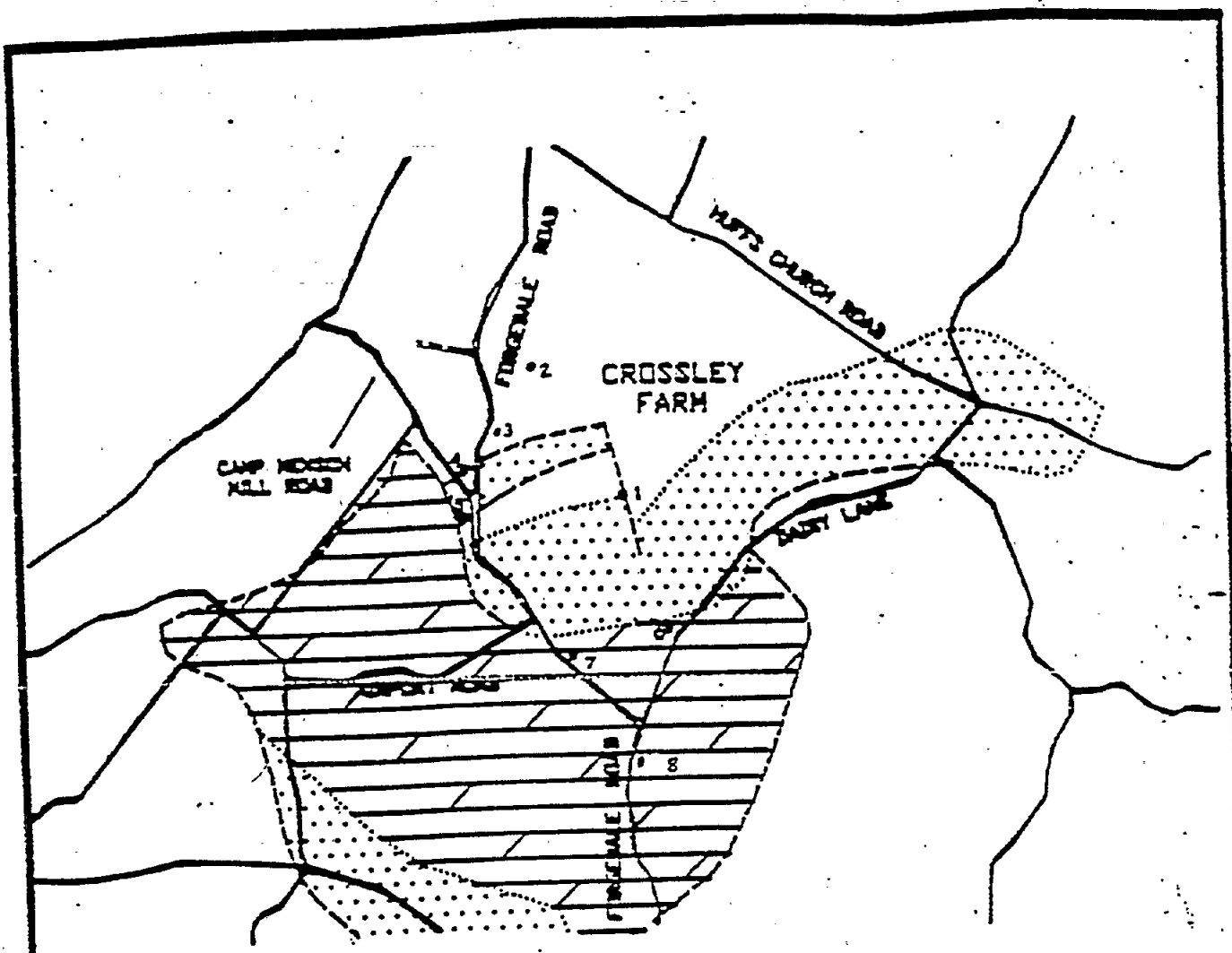
CROSSLEY FARM SITE, BUCKS CO., PA

(NO SCALE)

FIGURE 2

NUS CORPORATION

PROJECT AREA GEOLOGY



LEGEND

- BYRAM GRANITE GNEISS POCHUCK GNEISS
- HARDYSTON FORMATION
- LEITHSVILLE FORMATION
- FAULT
- CONTACT
- LOCATION OF SELECTED REAC INSTALLED BEDROCK MONITORING WELLS

SOURCE: Buckwalter (1959)

N

Ft.

0 500 1000

FIGURE 3

AR300039

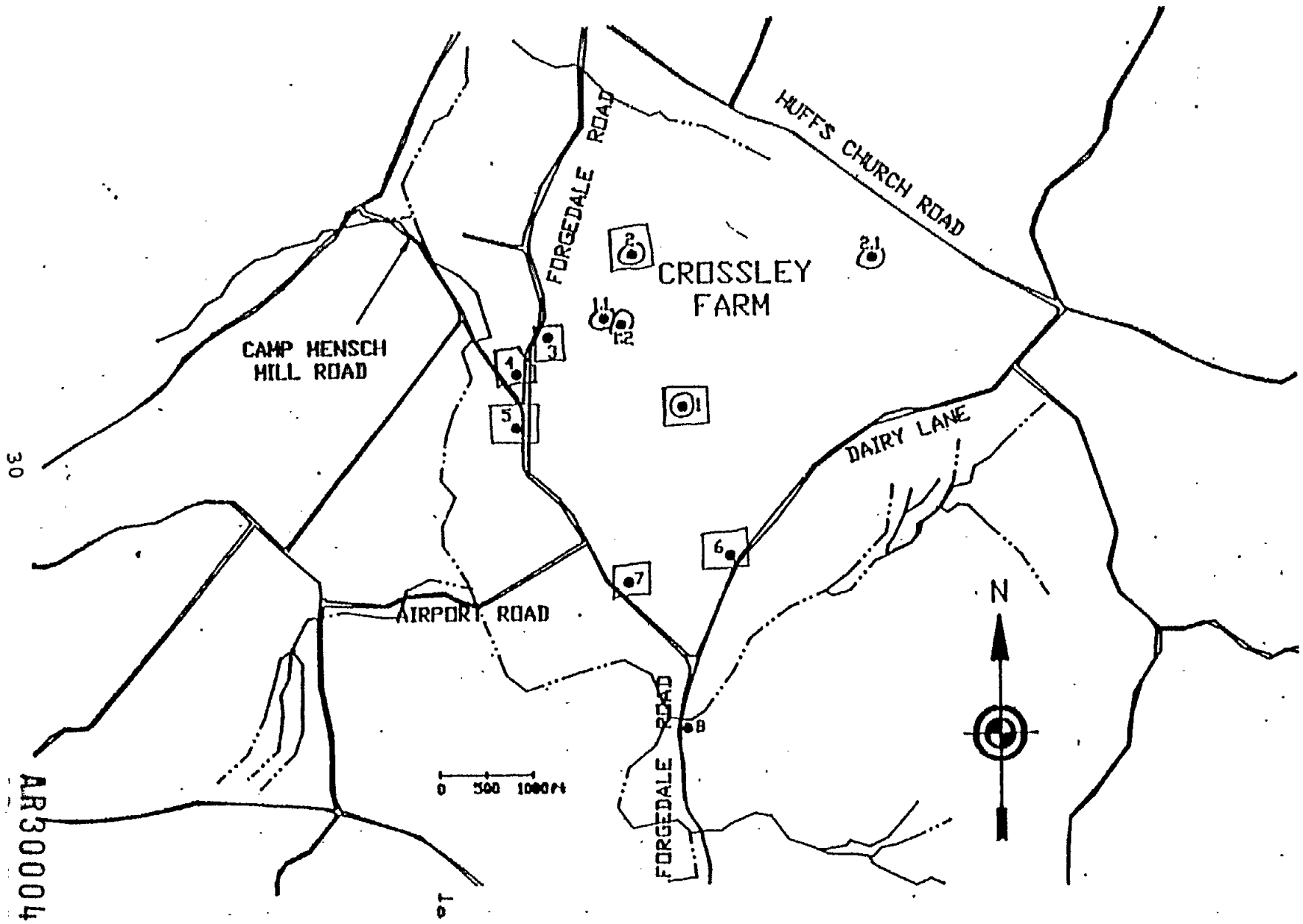


FIGURE 4

ERT/REAC INSTALLED MONITOR W[illegible] LOCATIONS

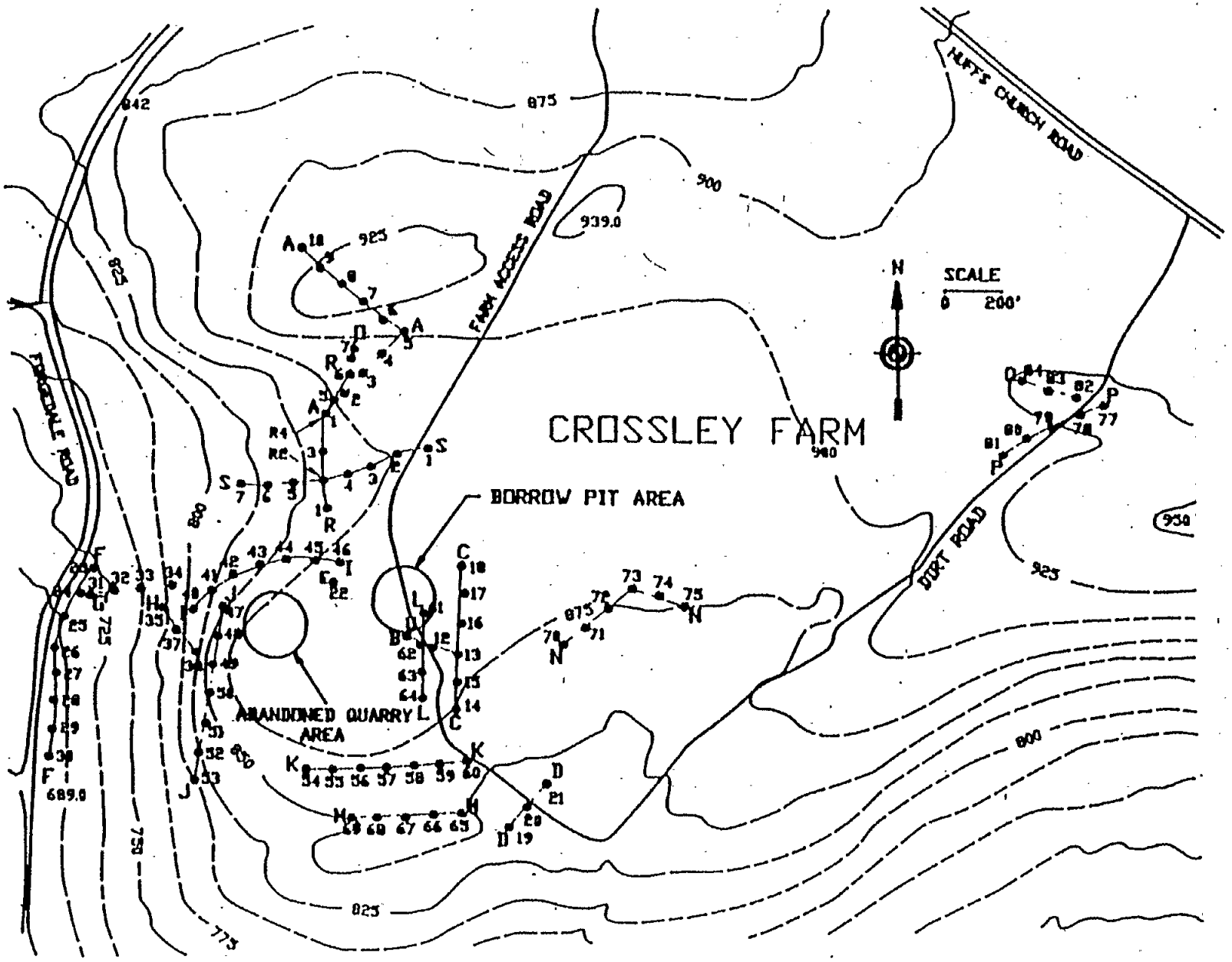


FIGURE 5

SOIL GAS TRANSECTS AND SAMPLING POINTS

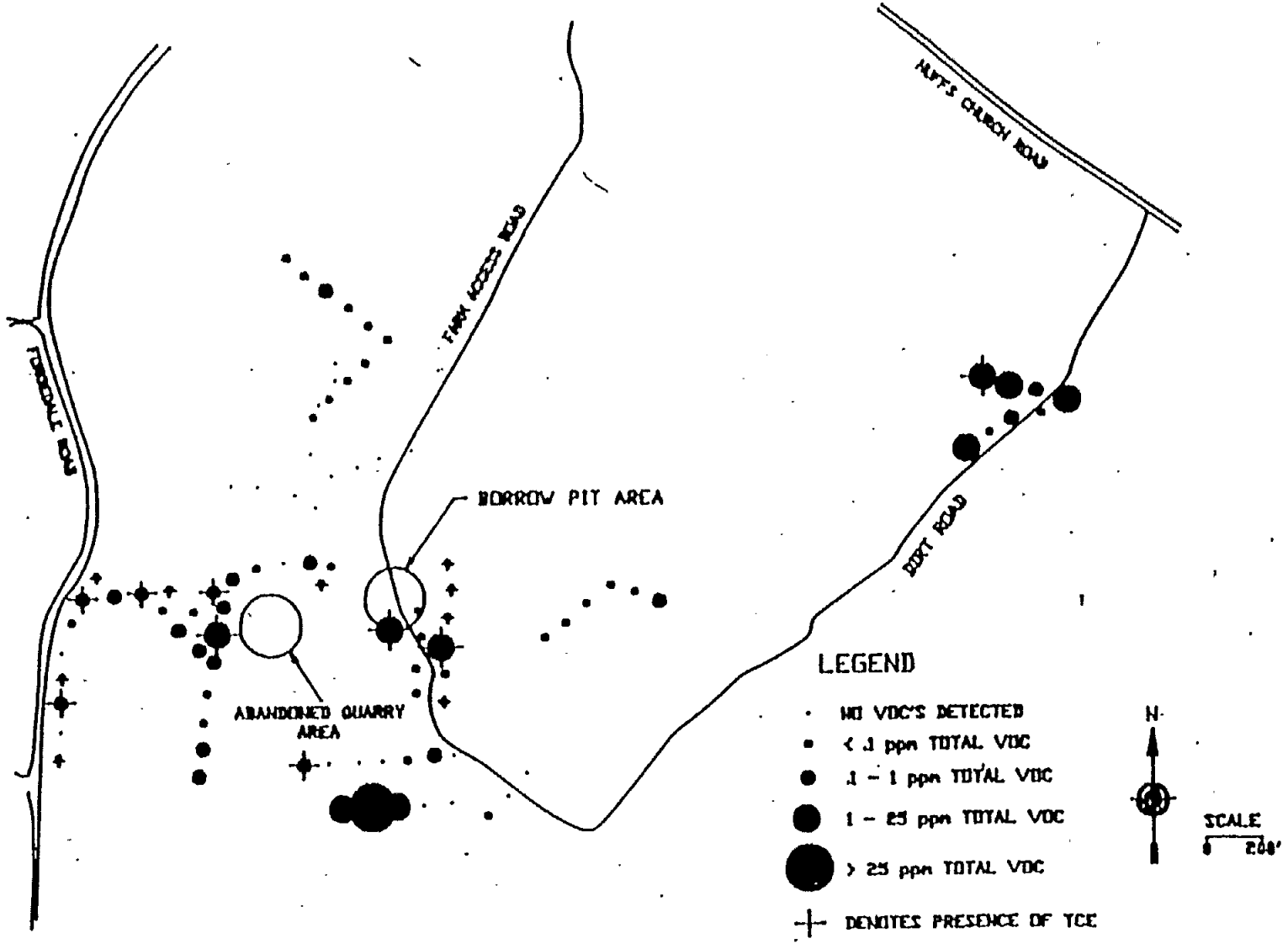


FIGURE 6
ANALYTICAL RESULTS OF SOIL GAS SAMPLING

APPENDIX B

LIST OF TABLES

TABLE 4
WELL CONSTRUCTION DETAILS

WELL	TOP OF CASING ELEVATION (msl)	CASING STICKUP (ft)	WELL DEPTH (ft) [a]	LENGTH OF SCREEN OR OPEN BOREHOLE (ft)	SCREEN OR OPEN BOREHOLE ZONE (ft) [a]	SCREEN OR OPEN BOREHOLE ZONE (msl)
MW-1-OB	849.77	2.73	56	10	46-56	804-794
MW-1-R	849.34	2.73	162	8	154-162	695-687
MW-1.1-OB	847.60	2.50	41	10	31-41	817-807
MW-1.2-OB	882.99	2.62	44	10	34-44	849-839
MW-2-OB	891.71	1.92	25	10	15-25	877-867
MW-2-R	892.19	2.60	50	18	32-50	860-842
MW-2-DR	890.88	1.25	305	249	56-305	835-586
MW-2.1-OB	933.83	2.25	60	10	50-60	884-874
MW-3-OB	701.73	2.13	23	10	13-23	689-679
MW-3-DOB	706.81	2.58	70	20	50-70	657-637
MW-4-OB	682.21	2.23	21	10	11-21	671-661
MW-4-R	680.55	2.04	237	11	226-237	455-444
MW-5-OB	688.94	2.08	32	10	22-32	667-657
MW-5-DOB	689.20	2.08	103	20	83-103	606-586
MW-5-R	687.93	1.92	302	104	198-302	490-386
MW-6-OB	646.39	1.75	41	10	31-41	615-605
MW-6-R	646.29	1.79	101	6	95-101	551-545
MW-7-OB	645.12	2.43	56	20	36-56	609-589
MW-7-R	644.18	1.96	95	37	58-95	586-549
MW-7-DR	643.57	1.14	123	15	108-123	536-521
MW-8-R	599.64	1.39	123	45	78-123	522-477

[a] Feet below ground surface.